



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

UNCERTAINTY AS A FACTOR IN PRODUCTION.

All economic effort is directed toward some economic good which is at once the incentive to action, and the result of that action. The effort is determined in nature and amount by the relation expected to prevail between outlay and result. Experience may give a definite idea as to this relation, or it may confuse the mind with uncertainty. It is the latter case which I shall consider in this paper.

In venturing on an economic undertaking, one may feel uncertain regarding the ratio of outlay to product or the relation of product to price. The former lies in the field of technique, the latter in the field of exchange, which is traditionally economic, but both affect production in precisely the same way and, hence, should be studied by the economist with equal care. In the first part of this paper I review the causes of variation and compare the different departments of industry in respect to degree of uncertainty. In the second part I analyze this factor and describe how it reacts upon and modifies production.

Uncertainty is a subjective state that has importance because it affects men's economic activities. To this state corresponds on the objective side the condition of irregularity in the product of like exertions or identical processes, or in the exchange value of equal volumes of products. A comparison of industries in respect to uncertainty is, therefore, a comparison in respect to the kinds, frequency and range of the variations that occur in them.

The collection or extraction of natural deposits is attended with great irregularity. As most minerals lie under ground, preliminary knowledge of them can be obtained only from the outcrop or from experimental borings or shafts. Once a vein or seam is located, and work begun, there is still the

danger that it will thin out or deteriorate, or be interrupted by a "fault." A change of dip may mock the labor of miners whose claims are located some distance from the outcrop. In fact, not until long after operations are begun does the length, breadth, outline and thickness of a seam appear. The form of combination of the mineral sought, its degree of purity, and its marketableness are likely to vary as mining proceeds. Even if the presence of the mineral, in the desired form and abundance, were to reward the sinking of every pit, there are still other sources of irregularity. The seam may occur in rock that can be honeycombed in every direction, or it may lie in loose soil, requiring expensive timbering at every step. The roof or walls of galleries are liable to collapse, owing to pressure, moisture or unsuspected qualities of the strata. Sinking, due to the underground operations, may disturb building or other improvements above ground, and occasion heavy damages. At any moment a hidden stream of water may be opened that will flood the mine, and require a great outlay for pumping or for cutting a drainage tunnel. Storms or freshets at the surface may interrupt operations. The liability to strike gas pockets, causing destructive explosions and fires, the condition of the air, determining whether artificial ventilation will be needed, the problem of disposing of debris, and the relations between capital and labor—all these inspire doubt and uncertainty.

Far more precarious than mining is the quest for water, oil or natural gas. While almost any well will yield some water, the extreme unlikeness in the results of digging drives men to the hazel wand, and like devices. Trial boring for oil or natural gas is proverbially speculative. The outlines of an oil field are not defined till hundreds of useless holes in the ground have been bored. Even within the field there are all manner of differences between wells. One taps a vein near the surface, another must probe to a great depth; one yields a few barrels a day, the other floods

the surrounding country with its waste; one spouts its wealth into tanks, from another the oil must be pumped at heavy expense. Moreover, apart even from natural exhaustion, there are fluctuations in the flow of an oil well. The output of a field or a factory does not depend on the number of neighboring fields or factories, but the yield of a well is very sensitive to the boring of adjacent wells, competition here producing the interference and mutual limitation so characteristic in the field of price.

The price realized per unit of product by no means varies so widely in these industries as does the relation of product to outlay. In the first place the variations in the output of a mine are due to local conditions, there being no general technical conditions, that by affecting all mines at the same time causes violent changes in supply, and consequently in price. In the second place, as mining products, such as coal, iron and copper, enter many of the arts at once, the demand for them is not apt to fluctuate much in a short time. While contracting in one direction, it expands in another, so that many of the changes in demand offset each other. The precious metals, while not occupying such a place of vantage in the arts, hold the unique position of money metals, and as such enjoy unlimited demand at a slowly declining value. In the case of precious stones, fashion rules the price, and hence the business is speculative.

The chief cause of the price variation of minerals is found neither in the capriciousness nor in the insensitiveness of demand, nor yet in irregularity of the yield from mining enterprises, but in the discovery and exploitation of new deposits. Discovery is to mining the same perturbing and dynamic influence that invention is to manufacturing. It is likely that when the whole earth has been surveyed by geologists as thoroughly as certain older portions have already been studied, much of the fever will die out of the mining industry. At present, however, with the gradual spread of the enterprising peoples over the surface of the

globe, the prices of minerals are constantly upset by unexpected finds and by rumors of such finds. The unsteadiness in price of such minerals as petroleum, nickel, manganese and tin is aggravated by the quickness with which by aid of power machinery the development of newly discovered deposits can flood and break down the market. But some minerals, such as salt, iron and coal, occur so abundantly and frequently that the deposits can be graded and production confined to the higher grades. This close gradation keeps the price from rising much through sudden access of demand or falling very suddenly, owing to discovery of new deposits. We might call this, *elasticity of supply*, seeing that it is the exact counterpart of "elasticity of demand."

An entirely different set of uncertainties surround agriculture. Here the chief source of irregularity is the weather, for temperature and moisture, those all-important factors of plant life, are quite beyond the ken or control of the farmer. In temperate zones, the putting in of a crop depends upon the withdrawal of frost, the amount of spring rain, the condition of the soil, and other factors affecting farm work. From the time the seed is committed to the earth the farmer plays a hazardous game for the life of the plants. Not only must there be enough of warmth, sunshine and moisture, but they must be properly distributed through the season and strictly limited in range of variation. A north wind may nip, an east wind may blast, a south wind may scorch, and a west wind may beat down the growing plants. Meantime the season that checks a growth of economic plants may favor the growth of weeds, while at the same time preventing the tillage necessary to subdue them. While the larger disturbers may be restrained, it is impossible to protect the crop against the parasites and micro-organisms that prey upon it. Rust and mildew, weevil and worm, bug and scale appear one knows not whence nor how, and must be endured as weather or any other inscrutable element.

The chief vicissitudes of farming are made clear in the following account of a concrete English experience given in the supplement to the *Economist* for January 9, 1892:

“Whatever the financial results of the past year may be, as far as farmers are concerned, they will always remember it as one of the most unreasonable, worrying and expensive of years. When it began, in the midst of one of the longest and severest of winters, they were just realizing the unpleasant fact that their outstanding crops of turnips were ruined by frost, and that they had before them the poor alternative of getting rid of some of their livestock at a sacrifice . . . or of feeding the animals to a great extent upon purchased food, with every probability of loss. Those who kept on all their stock, in the hope of an early spring, which was encouraged when February proved mild and dry, were sadly disappointed, March being a month of frost, snow and ‘blizzards,’ while April and one-half of May were wintry in temperature. In the second half of June, feeding and corn crops for the first time grew rapidly, and stock-keepers’ troubles were at an end, as far as forage was concerned, although lambs had been in many cases so stunted by the lack of succulent food in their early days that they never fully recovered. But the grasses and other feeding crops, owing to the wetness of the summer, were less nutritious than usual, so that grazing animals did not lay on flesh rapidly.

“In spite of the severity of the winter, wheat came up well, after lying in the ground from the time of sowing till the middle of February, except when it was sown early, which was not the case with the bulk of the crop. The exceptional dryness of the soil apparently rendered the unusually severe and prolonged frost harmless to sprouted seed and young plants. February was a very dry and comparatively mild month, so that a good deal of spring corn was sown early, while at intervals during March and April it was possible to get the rest of it in. Consequently at the end of

June, crops were in excellent condition, although extremely backward. But July proved very wet and cold, injuring the hay crop, then for the most part cut, and preventing the corn from maturing, besides laying the heaviest crops; while in August, when harvest was general in the early districts, rain fell so frequently that the work was seriously impeded, and the little corn that was carted was stacked in damp condition, some being sprouted and nearly all more or less stained. Nearly a fortnight of brilliant weather in the first part of September enabled the early harvesters to secure their damaged crops in dry condition. But this was the only favorable harvesting period, and the work was carried on at a great expense, by fits and starts, until a very tardy clearance of the fields was effected.

“In continental countries, the past year has been a bad one generally for farmers. The destruction of millions of acres of wheat in France, and vast areas of wheat and rye in Russia were the most striking catastrophes; but all other countries, except Italy, had deficient wheat crops, while rye was generally a failure, barley and oats being good crops in some countries, and poor ones in others. As contributing to the scarcity of food, the extensive prevalence of potato disease in Germany especially, may be mentioned.”

The amount of variation still present in farming, despite the elaborate soil cultures designed to meet the caprice of the season, may be attested by a few examples. In the Rheingau during the years 1884 to 1893, the results are estimated as follows: three-fourths of a good vintage, less than one-third, more than one-third, three-fifths, over one-half, over two-thirds, one-seventh, one-third, one-half. For six years the wheat crop of Hungary varied as follows, per hectare: 19, 14, 13, 18, 11, 18. During the same time, the yield of rye varied as, 16, 14, 12, 14, 12, 16; of corn, as 20, 17, 16, 18, 19, 16; of potatoes, as 110, 80, 77, 85, 91, 68. These variations, it must be remembered, by no means

express the vicissitudes actually experienced by the farmer. In calculating such averages, a vast number of local and individual variations cancel each other and leave no trace in the result.

This uncertainty as to crop often leads to waste at harvest. If the crop is under the normal, the task of harvesting, is, in a measure, lightened, and consequently the labor force of the farm is not fully utilized. On the other hand, if the crop is extraordinarily large, part of it may be lost for lack of help at the critical time. "Had the farmers of Manitoba," writes our Consul in 1892, "reaped half the grain grown on their farms last season, they would have been better off. Some men killed themselves trying to save the immense harvest, others have been broken down." *

As we approach the tropics, the unreliability of the season in respect to temperature diminishes. At the same time the practice of irrigation further reduces the uncertainty of farming by placing the supply of moisture under control. In Mexico "there is never a failure of crops or of fruits, for the presence or absence of rain is comparatively of little concern, as dependence is placed on irrigation altogether."

Many influences unite to make the price of agricultural produce extremely variable. Being to a great extent food stuffs, counted among the necessities of life rather than among its luxuries, the products of the soil have always been marked by extreme inelasticity of demand. Gregory King estimated that deficits in the British wheat crop of one, two, three, four or five tenths would cause a rise in price of three, eight, sixteen, twenty-eight or forty-five tenths respectively. "Much greater variations in price indeed than this have not been uncommon. Thus wheat sold in London for ten shillings a bushel in 1335, but in the following year it sold for ten pence." † Slight differences in supply, therefore, may cause violent fluctuations in price. But owing to the

* U. S. Cons. Report, No. 145, p. 328.

† Marshall, "Principles of Economics," p. 165.

presence of so many technical variables in agriculture, the volume of product is subject to very great changes. Moreover, the products of the farm are relatively perishable, so that the annual yield instead of reinforcing an already large stock, as does the annual output of copper or silver, constitutes by itself the total supply. The irregularities of crop become irregularities of supply, which in the face of an inelastic demand cause great unsteadiness of price.

It is true that the proportion of the productive power of society devoted to farming does not vary much from year to year. Large addition to farm acreage by opening up of virgin territory is a rather slow process implying the movement of bodies of men to new settlements and the founding of many homes. But this stability in the volume of agriculture as a whole is neutralized for any given crop by the ease with which its acreage may be altered by changing the use of land already under the plow. The system of diversified farming forbids extreme specialization of skill or capital. Tools, implements, buildings, draft-animals, labor, can pass over from the cultivation of one crop to the raising of another without much loss. A great increase in the production of a given article may therefore occur in consequence of a slight stimulus.

Again the absence of a continuous adjustment of agricultural production to the changes of demand makes for instability. The production period for cultivators, unlike that for other producers, is usually one year, and this period is entered upon by all at about the same time. The first consequence is that supply cannot be accommodated by the minor fluctuations of demand that arise in the course of the year. The second is that the simultaneous entrance on the productive process forbids one producer knowing what the rest are doing until it is too late to use the knowledge, the result being that agricultural production is planless and haphazard.

Prices are further unsettled by the way in which farmers who diversify divide their attention between the several

crops. All genuine adjustment of production to consumption aims to adapt the future product resulting from operations now undertaken to the future demand. The balancing of the coming product against a by-gone demand is no adjustment at all. Yet it is the custom among many farmers to increase the acreage of a crop that commanded a lucrative price in the preceding year. This absence of rational forecast of the future course of the market gives rise at times to a curious see-saw movement in the prices of farm product. A high price for potatoes or hops is followed the next year by a ruinously low price due to overproduction. This introduces a dangerous rhythm into agricultural prices.

The price of farm products, therefore, seems as uncertain as is the yield. But it frequently happens that these variations instead of reinforcing each other, serve to neutralize each other. The irregularities of agriculture, unlike those of mining, often flow from conditions that prevail over a vast area and bring similar fortune to a great number of producers. Sometimes it happens that when the turn-off of the individual cultivator is very large, the total supply of the crop is in excess, thus compelling a low price; when his yield is light, the total supply is short and high prices rule. In this way the two sets of variations partially compensate each other and, as in the case of two waves meeting half a wave-length apart, the result is smoothness.

Again the practice of mixed farming tends to lessen the farmer's hazard by broadening the basis of variation. If three crops happen to vary in the same direction at the same time, the fluctuation is no more serious than if sole reliance had been placed on any one of the crops. While, if, as is more likely, the variations do not coincide in direction, they will partially neutralize each other and thus lessen the risk of the farmer.

Similar to agriculture, but having, besides, certain risks of its own, is fruit growing. Here the complete period of production spans from eight to thirty years. There is not

only the irregularity of the fruit crop from season to season, owing to the same capriciousness of weather that makes cereal crops fickle, but there is also the risk of losing at any moment by lightning or flood, by frost or sun blight, by parasite or disease the heavy capital sunk in the fruit trees or vines. The crops of the farmer are so many growths, rising at intervals from independent roots, while the annual harvests of the orchardist are branches springing at intervals from a common trunk or stem of fixed capital. In the former case the growth may be killed, but the soil for its successors remains; in the latter, either the individual branches may be destroyed or the stem from which they rise may be cut down.

If the complete period of production averages for horticulture, say ten times as long as for agriculture, an opportunity for the producer to revise his judgment is presented but one-tenth as often. The industry is, in consequence, less flexible since supply cannot be adjusted so promptly to the varying needs of the market. As it is conservative, neither responding with alacrity to advancing nor declining quickly with falling prices, we find in this branch periods of over-production accompanied by unremunerative prices, succeeded by periods of prostration and under-production, characterized by buoyant prices and good profits. These variations by no means exempt horticulture from the minor variations that attend all crop industries. These are a series of ups and downs superimposed on the more fundamental alteration of ruling low prices and ruling high prices.

The high perishability of fruits in their most marketable form is another source of peculiar variation in value. Urgency of sale throws into the market at the risk of glut a crop that, if more durable, might be fed gradually into the market with the result of steadying prices and lessening the risk of the producer.

Few are the industries that show a variability equal to that of fisheries. Here we seem to find combined the

invisibility of source of supply so characteristic in mining and the seasonal fluctuation that prevails in agriculture. The annual appearance of schools of fish at a given fishing ground may be interrupted by the presence of enemies, the absence of accustomed food, the nature of the current and other factors as yet unknown. The catch of the Norwegian cod fisheries during five years varied as 21, 16, 27, 28, 38. At Loffoden the averages were for each fisherman 107, 106, 81, 57, 98, 69, and the profit for the same series of years averaged 22, 16, 19, 19, 24, 22.* Weather is an important factor in determining the diligence with which the fish can be pursued. We read that "the catch on . . . the Varanger Fiord was hindered by continuously bad weather," or "the cod catch was also much interrupted by the weather, and many of the fishermen were compelled to leave the grounds before the close of the season, having lost large quantities of their nets and other outfits by the heavy storms." The condition of the fish also varies unaccountably. Sometimes they are lean, and three times as many livers are required for a quart of cod-liver oil as in other years.

Quotations serve to bring out clearly the mutations of fortune. Of the Norwegian fisheries of 1891 we read: "The whole course of the fishery this year was highly singular."† "The lobster trade was bad, and in these parts complaints are frequent that the quantities as well as the sizes are yearly declining."‡ "The herring fisheries have always been very capricious in regard to . . . the quantity and value of the produce."§ On the Swedish coast "The records show that at different periods the herring suddenly appeared, frequented the shores for fifteen or twenty years in succession, . . . and then as suddenly vanished and were seen no more for a much longer period." "Again the fishermen along the

* United States Consular Reports, No. 141, p. 245.

† Ibid, p. 247.

‡ Ibid, p. 248.

§ Ibid, p. 245.

Gaspe coast . . . are in a state of poverty and many of them dependent upon relief from the government. At last they feel that their vocation has become too precarious to rely on for a living and many have gone away in search of more promising fields of labor."

In fishing oftener than in any other industry the variations in the value of product tend to offset the variations in the yield, so that the two sets of variations partially correct each other. The returns of the fishermen may, therefore, be more regular than either product or price.

In stock-breeding and raising new elements of uncertainty appear. While weather and season are not so tyrannical as in agriculture, and while animals, though extremely susceptible to disease, can be surrounded with artificial conditions and receive remedial treatment, we have a new element of risk in the very activity of the animal. The relative freedom that must be granted to stock opens the door to self-injury or mutual injury in ways that ordinary foresight cannot guard against. In breeding, too, there is a peculiar element of uncertainty in the variations that come in between generations. The colt of the ordinary horse has possibilities of fame on the turf, while a large proportion of the offspring of the rarest strains exhibit only ordinary qualities.

We may say, then, that all kinds of production having to do chiefly with living organisms—agriculture, horticulture, viticulture, dairying, stock-raising, oyster-farming, poultry-raising, pisciculture, canary-breeding, silk-raising, wool-growing, fishing, sealing, whaling, hunting, etc., are open to uncertainty from one or more of the following causes:

1. Lack of knowledge as to the life habits of the species (trapping, fishing, pearl-diving, silk-raising).
2. The difficulty of realizing artificially the elements of a perfect environment (stock-breeding, floriculture).
3. Lack of control over the supply of certain essential factors, such as moisture, sunshine or heat (agriculture, viticulture, horticulture).

4. Ignorance as to the results of uniting different lines of heredity (breeding).

5. The low resistance of cultivated species to the attacks of parasites (stock-rearing, silk-raising, viticulture).

6. Injury resulting from the caprice of animals (stock-rearing, ostrich-farming).

7. Exposure of the organism throughout its life to the inclemency of the weather (agriculture, viticulture).

8. Necessity of conducting operations out of doors subject to weather conditions (fishing, farming).

Aside from the ice industry and lumbering, the remaining departments of extraction, such as quarrying, the collection of guano, india rubber or cork, the gathering of borax, salt, etc., where the supply is visible and is not affected by the weather, do not show any marked variability.

Transportation is a business that, from an uncertainty almost proverbial, has attained a high standard of precision, exhibiting constant relations between outlay and result, and hence admitting of secure prediction. Primitive water transportation depending on wind and currents for motive power, braving in small and frail vessels the violence of the tempest, and venturing the treacherous main without chart or compass, was a lottery with few prizes and many blanks. Early land transportation, while less dangerous, had to take the roads in such condition as weather and season allowed, and was moreover troubled by the fear of molestation. Water movement has been emancipated from many perturbing influences by the increase in the size and strength of ships, by the use of steam, permitting the mariner to ignore the power of wind or current, by the improvement of steering apparatus, by the surveying, mapping and charting of coasts and harbors, by the perfection of instruments for finding bearings and direction, by the reduction in the amount of handling needed for a ship, and by the better policing of the seas. Season, of course, still continues to affect sea movement, and on canals and rivers there is room

for considerable variation in the length of the annual closure by ice.

Land transportation has improved in certainty with the substitution of inanimate power for that of animals, with the improvement of the way whereby a road becomes a uniform specialized track almost unaffected by season or weather, and with the use of specialized vehicles, permitting the movement of persons or goods with equal safety and comfort at all times. From a stage at which way, vehicle, and motive power are subject to uncontrollable influences causing great irregularities, to the modern railway service carrying out its program with a perfect precision regardless of weather and season, we have a steady increase in certainty. But while a rhythm of movement in exact conformity to a prearranged schedule signalizes uniformity of results, we must not overlook the varying costs at which these unvarying results are obtained. Though the passenger or shipper may perceive no disturbance of movement through the year, the operating department records the extra cost occasioned by the use of a snow plow, the replacement of trestles and bridges washed out by freshets, or the renewal of rain-rotted ties.

Coming now to the manufacturing industries, we note that the contrast with the extractive branches in respect to variation is marked. Mining, for instance, depends on an unseen quantity of natural deposits occurring under unknown conditions. The manufacturing industry, on the contrary, depends on the capacity of a given complex of buildings, mechanism and labor to confer upon raw materials certain definite changes of form. In agriculture and the kindred branches there is transformation, but the chief transforming elements are supplied as nature sees fit to furnish them; while in the elaborative processes practically all the conditions of transformation are provided by man according to judgments based on experience. In growing the transformations must be effected through organisms subject to the

laws of heredity, environment and variation, and not fully understood or entirely manageable by the average producer. In manufacture the changes are for the most part brought about by the submission of materials to an artificial series of harmonious, simple and well-understood operations. If this series were ordered by heredity instead of by human judgment, and if its terms were complex, correlated, and little understood, we should have a parallel to those industries dealing with plants and animals.

There are yet other contrasts to be noted between growing and manufacturing. In the one case the power applied is vital; in the other mechanical. In the one case the operations are conducted out of doors; in the other case under shelter.* In the one case changes of season, temperature or moisture† interrupt operations; in the other case the processes take place under uniform and appropriate artificial conditions that shield them from disturbance from without. In the one case the form embodying the results of the partially completed series of transforming processes is out of doors liable to be injured or destroyed; in the other case it is protected at all stages. The security of the house plant as contrasted with the exposure of the field or vineyard plant typifies the difference between the object undergoing manufacture and the object undergoing cultivation.

The reasons for the superiority of manufacture in respect to certainty are partly technical, partly economic. An elaborate industry in the definiteness of the transformations it undertakes and in its detachment from any particular spot must stand in high contrast to a purely extractive industry, like mining, which here and there blindly probes the earth's

* Building, paving, dredging, charcoal-burning, stone-dressing, cotton-baling, tobacco-stripping, brick-making and a few other operations not extractive, are frequently carried on in the open air. But nearly all the remaining industries that work up materials are carried on under shelter.

† But the weather affects cotton spinning and weaving. It is found in Lancashire that when the weather is dry with continued east wind and frost, the cost of weaving is increased 5 per cent as compared with moist weather, and the product is worth 5 per cent less.—U. S. Cons. Report, No. 12, p. 128.

crust for minerals. In the intensiveness that enables its operations to be conducted in a space so small as readily to be enclosed under a roof, it enjoys an advantage over agriculture that must be extensive in order to employ the power of sunlight and the materials of the air. And from these primary differences flow most of the contrasts above noted.

But there is an economic reason for guarding manufacture with such precautions as shall insure a high ratio of success to failure. If a fishing cruise is fruitless, a crop fails, or a mine does not yield, the loss is chiefly in labor expended and capital worn out. But if a batch of syrup is burned, a tank of petroleum overdone, a vat of beer spoiled, or a piece of cloth badly cut, the miscarriage involves the loss, not only of labor and capital, but also of valuable materials. Consequently the motive to reduce variations by artificial means is greater in the latter type of operations than in the former.

Now the manufacturing industries lying nearer to the consumer than the extractive branches are engaged in giving the final transformations to partially worked-up materials. Occurring further along they deal throughout with materials of relatively high cost, and so risk more in submitting to irregularity. The disposition, therefore, to go to trouble and expense in order to insure success, is greater here than elsewhere, and so failure is rarer. It is on the same principle that there are more breakages in dusting cheap parlor ornaments than in dusting costly bric-a-brac.

Granting the motive for superior precision, how may it be attained? In intrusting technical operations to men there will be variations in result due to the variability of condition. The incalculable element of mood, that is the parent of such amazing aberrations when the artist, such as poet, writer, architect, designer, composer or painter, undertakes a set performance by schedule time, cannot be disregarded in the higher types of skill. The use of machinery in many of the delicate operations formerly intrusted to skilled artisans greatly increases the precision with which a

given pattern is reproduced, a given standard of finish attained, or a given quantity of result achieved. The conditions of standard efficiency are not only fewer and simpler in the mechanism than in the man, but they are more under the control of the producer.

Precision is furthermore secured by substituting the accurate technical knowledge of chemists, metallurgists and mechanical engineers for the traditional trade-lore and ancient rules-of-thumb of the handicraftsman. As trained professional direction lies within the means of a large establishment rather than of the small shop, we find more variations in the small undertaking than in the large. This affords to the latter an advantage that aids it in vanquishing its rivals.

But after all is said, after the polariscope has become the servant of the sugar refinery, the spectroscope of the steel manufactory and the microscope of the brewery, there are still uncertainties in manufacture.* The following résumé of the defects of crown glass is in evidence: "Perhaps the glass has been badly melted and is seedy, that is full of little vesicles . . . ; or the gatherer may have enclosed air within his 'metal,' and a gatherer's blister is the result—or a pipe blister or pipe scales, or dust from the pipe nose, or dust from the marver, or dust from the bottoming hole, or dust from the nose hole, or dust from the flashing furnace, or bad bullions or scratches, or music lines, may disfigure the table, while the glass may be crizzled or curved, or bent, or hard, or smoky."†

As regards price, manufacturing industries enjoy rather high stability. The evenness of output from a given expanse of equipment permits a close adjustment of supply to demand and prevents those wide oscillations so noticeable in the prices of natural products. It is true that many branches of manufacturing are relatively inflexible

* In the firing of pottery, the making of steel, or the grinding of lenses, there are peculiar risks.

† Tenth Census, Vol. ii, "Glass Manufacture," p. 45.

on account of the large sums of fixed capital employed in them, which cannot be extricated at all or else can only be slowly withdrawn. Similar is the immobility of the specialized skill found oftener in manufacturing than in mining or growing. These make for a rigidity of supply which does not admit of rapid and easy adjustment to a variable demand. This slow response to the hints afforded by changes in price permits prolonged derangement in the relation of price to cost of production and hence is a factor of uncertainty that must be reckoned with. The evil finds a remedy in the control of supply through the "trust," a form of business which when perfected does undoubtedly promote the stability of prices.

Yet it is doubtful if the liability to overproduction followed by prostration is as great in manufacturing as in mining or plantation industries. The sinking of a shaft, the building of a sluice or irrigation ditch, the clearing of a plantation for sugar cane, vines or bananas constitutes a permanent improvement, while the capital of a factory though highly durable is at best not permanent.

As manufactures are not such imperative necessities as are many soil products, the demand for them is more elastic and a given price variation does more to restore equilibrium of supply and demand than a like variation in the price of meat or wheat or salt. If there is excess, small reductions stimulate an answering demand; if deficit, the rapid shrinkage of demand under the chill of dearness soon brings about an accommodation. Precisely the same effect is achieved by widening the market area. If social demand is unresponsive to moderate price-cutting, an outlet for a surplus may be got by resort to distant markets. While the unloading of a local surplus in markets belonging to other producers propagates a disturbance rather than allays it, the effect is certainly to steady prices in the local market. Now the extensibility of the market depends on the portability of the goods. If bulky or heavy a large sacrifice in

net price will extend the market for them in but slight degree; while if they are light, a relatively small outlay for transportation will greatly widen the area of sale. Moreover an improvement of transportation, leveling as it does more and more the rising line of cost for shipment from the place of production, not only increases the expansibility of the market for the two classes of goods but favors one more than the other. As manufactures have greater value in a given bulk or weight than natural products, the relief to the producer of them will be greater. In the annexation of adjacent zones by incurring cost of shipment, we have an exact analogy to the penetration of goods to unsupplied social strata by concessions in price.

Having now completed our survey of variation in the different departments of industry we shall consider the ways in which uncertainty reacts upon and modifies production.

In its best estate, the social system founded on private property and individual initiative tends so to distribute the aggregate productive powers of society, as to lead to the largest possible output of goods and services, measured in respect to their money value. Now though this result is never actually realized, it is so evidently the point toward which converge the workings of the chief features of our system, that it will be convenient to gauge some minor features by the degree to which they cause the system to fall short of this ideal. Such a disposal of the resources of society as described above would be Economic Production and the quantity of any commodity produced during a given interval would be an Economic Supply. These concepts do not exclude the possibility of the variations we have described in the first part of this paper. The idea is not that an equilibrium should be maintained from moment to moment, for this would imply an impossible fluidity of capital and labor, permitting instant transference from branch to branch. The idea is rather that an Economic Supply of any kind of goods is realized when over a considerable period the

total result measured by money equals that attainable if the productive powers employed had been devoted to some other purpose. The fact that this total is a sum of variable returns from uniform productive outlay in no wise deprives it of the "economic" quality.

We see, therefore, that variability in relation of outlay to product, or of product to value, is not, as such, incompatible with Economic Production. Where, then, does the reaction on production come in? The origin of this we must seek, not in variability, but in the uncertainty that results from it. Variability is an objective fact; uncertainty is a state of mind, and as such is the parent of extensive derangements of Economic Production. To two disturbing subjective states does uncertainty open the door. In the first place, from the confusion of judgment arising from the experience of unforeseen variations issues hesitating estimate, influenced largely by temperament, feeling or accident. In some lines of undertaking, such as gold mining, or under certain conditions, such as speculative fever, the estimates will be shaped too much by hopefulness, and hence too much productive effort will be expended. In other lines or at other times, men's estimates will be unduly influenced by dread, and here again the supply will fail to be economic.

A second consequence of uncertainty is connected with the differences in the subjective estimate put upon like quantities of money value by the same individual. From the law of declining utility, it follows that a man's ninth hundred dollars is not worth so much to him as his eighth hundred, and so on. Now if, with an expenditure of effort sure to yield him \$799 of product in one line of industry, a man has precisely equal chances of a return worth \$700 and a return worth \$900 in some more variable branch, he ought to accept the chance if we are to realize Economic Production. For an equal chance of \$700 and \$900 means that in a series of periods the average return would be \$800, showing this employment to be more economic than the other. Yet, as

the \$101 that the producer might gain by changing is worth less to him subjectively than the \$99 he might lose, he will with perfect economic propriety decline to enter the less stable business.

It might here be objected that this derangement flows from variability and not from uncertainty, inasmuch as the producer is *ex hypothesi* certain that the chances are really equal, that is, that if he gets \$700 this year, he will get \$900 next year, or, in any case, he will get in, say ten years, a total of \$8000. But even if there is the certainty of getting \$8000 in ten years of work, there is no certainty to the producer that he will live to complete the period and win the reward. And if not, it might happen that the earlier years would be the lean ones. I conclude, therefore, that even in such cases, uncertainty is the root of the difficulty.

If industries were not unlike either in respect to their tendency to inspire confidence or caution, or in respect to their variability, it is hard to see how the mere fact of variation could make production uneconomic. It is on the margin of difference between industries that the subject factors disport themselves and beget the consequences I shall describe.

The prime consequence, therefore, of uncertainty is an under-appraisal of the rewards of the risky lines of enterprise leading to industrial anæmia. Corresponding to this under-supply, there is in the more regular industries a congestion of productive powers begetting over-supply. But the full effect of uncertainty is not allowed to confine itself to relative supply. By certain adaptations of industrial structure, uncertainty is reduced in influence, and actual supply approaches more closely to economic supply than it otherwise would. These modulations of types and forms to a condition of instability constitute a series of secondary effects that lessen the primary effects. For example, the primary result of cutting a man's income in two is loss of satisfaction; but it also leads to a different distribution of

expenditures, to a more careful comparison of different wants, and to a more economical use of what is obtained. These secondary consequences are not only richer in effects than the primary one, but they tend to lessen the primary effect itself. In like manner the secondary consequences of uncertainty are more significant than the primary disturbance in supply.

The amount of uncertainty depends on the amount of variation to which an enterprise is exposed, the law being that the greater the range or number of distinct variations the greater will be the feeling of doubt. Now the amount of variation depends upon the period of time we take. In copper mining the probability of a great fall in price by the discovery of new mines, or of a great rise in price through expansion of commercial demand, is certainly greater if we take the next ten years than if we take the next five. The danger that the price of a manufactured article will decline owing to betterment of the machinery for making it is certainly greater the longer the period, if we admit, as we must, that more improvement is likely to occur in eight years than in two.

The amount of variation that must be endured by an enterprise is that occurring between the moment when an unfavorable alteration is perceived and the moment of withdrawal. If exodus is practicable within one year, the exposure to variation is less than if two years were needed in order to extricate one's self from the declining industry. Flexibility is, therefore, an advantage, and is a greater advantage in a variable industry than in a stable one. As flexibility depends chiefly on the extent and form of auxiliary capital employed, the distinction just made resolves itself into a contrast between businesses with fixed capital and those without. A business that employs capital in forms so specialized as to be unavailable for any other economic purpose and so durable that its value cannot be recovered from the product for a number of years, cannot promptly adjust

itself to a fall in the price of its products and hence is exposed to prolonged loss. A business, on the other hand, that employs little durable capital and that not highly specialized, is flexible and permits easy exodus if the outlook become forbidding.

The effect of superadding to differences in flexibility the element of uncertainty in price is to exaggerate these differences. Differences in flexibility of little moment in the stable branches have important consequences in the more speculative branches. One effect, of course, is to check the flow of industrial energies into doubtful enterprises which demand a heavy initial outlay. The clearing of land for a special crop such as coffee or cane, the building of sluices for mining a speculative metal, the creating of an irrigation system for a valley depending for access to market upon a very dubious railroad expansion, are cases in point.

Another effect is to hold production down to an inferior technique. Articles of fashion are made by hand rather than by machinery, not so much because hand labor is superior, as because it involves less outlay of capital. The same thing is visible when the business is under the menace of a possible substitute. The effects of rapid electrical development upon the technique of gas works, of the possible cable car, upon the ratio of circulating capital to fixed in the conduct of horse-car lines, of the ubiquitous trolley car upon the building of Macadam roads exemplify this. A business facing a squally future must not spread much sail. Where there is doubt of the outcome the entrepreneur must hold himself in light marching order, ready to move at a moment's notice.

Similarly any uncertainty regarding dynamic variations, *i. e.*, changes in the direction of progress, tends to depress the technical excellence of production by delaying the introduction of an admitted improvement requiring large outlay. When inventions in a certain line follow rapidly on one another's heels, each overtopping the one before it, a timid

and conservative spirit appears among producers. They fight shy of improved but costly machinery or expensive changes in methods, not from sluggishness but from dread of new inventions that may unsettle prices and supplant the forms that commend themselves for the moment. If production clings to its old ways, looking for an invention that does not come, we have an uncovered loss to society; the possible Best blocking the feasible Better. Of course if the looked-for improvement *does* come, there is a saving effected by the prudent slowness of the cautious producer. But we know that with private initiative this prudence will be pushed farther than the interests of the collective economy require and the losses from delay will exceed the gains.

The uncertainty as regards the yield of product sets up a current of amalgamation that favors large-scale industry. In almost any line of production, minor fluctuations are constantly occurring in the different parts of a business. As, however, these succumb to an average within the single enterprise, they inspire no uncertainty and are not disturbing factors. The larger the enterprise, the more do the variations incident to its branch of production reduce to an average and disappear, the fewer are the uncomprehended species of variation. For instance, to the owner of a cow the loss at calving time is uncertain, while to the owner of a great herd this loss appears as a regular percentage that can be computed and allowed for. Even to the rancher the loss by stampede is uncertain, but to a great cattle syndicate with many herds, the loss from this source can be roughly estimated in advance. Again, in a small refinery the possibility of overdoing a batch of oil or sugar may be a source of serious uncertainty, while in a large refinery the law of the average prevails.

Thus with increase in the comprehensiveness of the individual enterprise, the species of variation that do not succumb to the average but remain sources of doubt, become fewer. This gives rise to three types of enlargement; to

amalgamation or the fusing together of co-ordinate processes as, for instance, in mixed farming; to *comprehension* or the fusing of successive processes as, for instance, in the pottery industry; and to *expansion*, or the repetition of the same operations as in the big cotton mill or refinery. This may be conceived to go on until in the perfectly centralized trust or in the bureau of the collectivist state the uncertainty due to technique reaches a minimum.

It follows then that in the variable branches the small enterprise will be unduly starved, while the large undertaking will flourish beyond its economic limit. It will be observed, however, that where we have to do with the fluctuations of price rather than of yield this effect is absent. The movements of price affect the entire product at a given moment and are not overtaken and engulfed as an enterprise expands.

The effects of uncertainty on business management are two, both springing from the same root. It follows from the law of declining utility that the smaller the equal portions of a man's capital we compare, the less is the difference in subjective value. To a man who values his second and third thousand dollars in the ratio of 3 to 1 a fifty-ninth and a sixtieth thousand may stand in subjective importance as 18 to 17. Now such a man with \$2000 of capital could not afford to invest in an uncertain instead of a safe business unless the chances of gaining an extra thousand dollars were three times as many as the chances of losing that amount. This could not occur till actual supply was so far behind Economic Supply as greatly to raise the price of the article and consequently its rate of profits. But if this man had \$59,000 of capital he could afford to embark as soon as the chance of gaining stood to the chance of losing as 18 to 17. We may conclude, then, that those who risk but a small portion of their capital in a single enterprise can carry production up much closer to Economic Supply than can those who risk most or all of their capital.

Now most variations of product, especially in mining or manufacturing, are confined to the individual establishment; variations of price, however, extend to all enterprises in the same branch of production. From this it follows that the one least able to make a doubtful venture is the small undertaker who embarks his entire capital; abler is the rich man who supports several other enterprises in the same line of business; ablest is the man of ample resources who has many investments in widely sundered departments of activity. Our first discovery, then, regarding business management is that poor men will confine themselves to the steadier branches, while the variable branches will fall into the hands of men of large resources; and unless there are enough rich men to man the speculative branches there will be an under supply, leading to high profits, which will be reaped by those who are able to engage in them. Thus monied men by capturing the lucrative fields of enterprise will widen still more the gap between themselves and the mass.

But with a rapid growth in the size of the business unit, the great fortunes prove too few to handle the big enterprises. Hence the joint-stock corporation is invoked to supply masses of capital without calling on the rich man. Albeit the stimulus to corporate enterprise has been ascribed to the growth of great industry, no small measure of its success has been due to its fitness for uncertain undertakings. By owning stock in a dozen different corporations and sharing in a dozen undertakings, one is exposed to twelve times as many variations, but each disturbs only one-twelfth as much as when one is proprietor of a single enterprise. Some of the numerous variations will cancel each other, and the rest will locate their effects at the margin of one's fortune, where the subjective value of equal losses and gains is nearly the same.

The corporate form, therefore, is at its best a mutual insurance scheme, whereby the losses and gains due to

variations are first pooled, and then shared equitably among a large number. By thus enlarging the bearing and absorbing surface, by creating a solidarity through the interlacing of many private interests, the difference between the variable and the uniform type of production is minimized. While there is a corporate drift all over the field of business, we find it most pronounced in speculative branches, such as mining, boring for oil or gas, electric enterprise, building and improvement undertakings, the theatre business, and the introduction of new devices, machines, utensils, toys, foods, fibres, fuels, etc.

The triumph of the corporate form in risky branches is prevented by the growth of specialized insurance companies, which, in consideration of a premium, assume certain risks as cheaply as a corporate enterprise could assume them. Here the loss-bearing power of a corporation is utilized, while at the same time the actual conduct of business remains in the capable hands of individuals. But the aid the insurance company can render is limited. It is impracticable to sort out of the career of an enterprise all the untoward variations, and hire a corporation to accept them. Only those losses that are important, static, that can be isolated, and that flow from a cause beyond the control of a proprietor, can safely be assumed for a consideration. But most of the variations I have described are so imbedded in the texture of a business that isolation is impossible. They must be borne by the entrepreneur.

The unlikeness of industries in variability brings about a psychological segregation of men. Where result is extremely variable, as in prospecting, gold mining, boring for gas or oil, blockade-running, smuggling, opening of new markets, etc., or where price is extremely variable, as bonds of doubtful governments, mining shares, trust certificates, agricultural produce, etc., certain adventurous speculative spirits crowd in and take charge. In the safe industries, on the other hand, we find the cautious, prudent, calculating

men, who love precision and settledness, abhor hazard, and are terrified by uncertainty.

Summarizing we find that in the more variable branches of production:

1. The inflow of productive powers is less than it should be.
2. The ratio of fixed capital to circulating is less than is economically desirable.
3. The large concern enjoys peculiar advantage over the small concern.
4. A high rate of profit prevails, reaped for the most part by men of large means.
5. The corporate form of industry prevails more than elsewhere.
6. Special agencies are called into being, and induced to assume the consequences of certain unfavorable variations.
7. The sanguine, hopeful, adventurous class crowd in, while the cautious, timid class of men betake themselves to other branches.

EDWARD A. ROSS.

Stanford University, California.